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(54) Urban remote surveillance system for street lamps

(57) Urban remote-surveillance system for street lamps, in which a concentrator module (1) sends, using a very low power transceiver, by means of a polling procedure, a message to each of a plurality of remote-control modules (7,8,9,10) equipped with a very low power transceiver and organized in a hierarchical tree structure, defining in the message the destination module and a receiving/transmitting path consisting of a plurality of intermediate modules able to communicate with each other in succession, at the same frequency and without mutual interference, so as to obtain the necessary geographical coverage also using very low power transceivers.

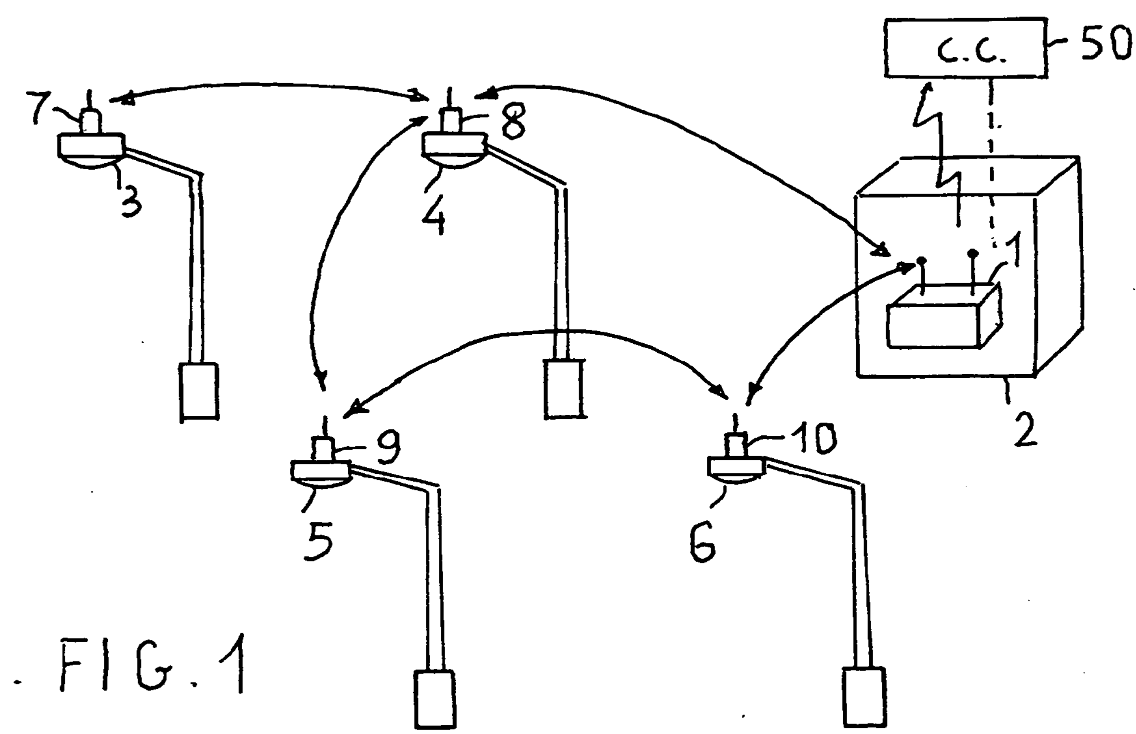

FIG. 1

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Description

[0001] The present invention relates to an urban remote-surveillance system for street lamps and more generally to a system for monitoring events which do not require immediate action.

[0002] It is known that the operation of urban lighting systems poses not insignificant problems with regard to the logistics and management thereof and that, in an attempt to remedy them, various solutions have been proposed.

[0003] For example the document US 5,479,159 describes a system in which a monitoring device (microprocessor) powered by the same network supplying power for the lighting system is associated with each lamp and detects and stores the state of each associated lamp.

[0004] The power supply network acts as a communications line by means of which the various monitoring devices are periodically interrogated and provide responses indicating the state of the associated lamp.

[0005] The conveyed-wave communications system has considerable drawbacks (possible electrical disturbances, problems of isolation, attenuation of the signal along the lines, need for receivers and repeaters for the electrical transformer cabins).

[0006] It has therefore been proposed, as an alternative described for example in the document US 6,035,266, to associate with each monitoring device a radio-transmitting station (or also radio-receiving station) which, in the event of identification of a possible malfunction, sends, of its own initiative, a message to a base station.

[0007] For greater reliability the message may be repeated several times.

[0008] In order to reduce to a minimum the risk of interference between several monitoring devices transmitting simultaneously, the transmission frequency is chosen randomly from a frequency spectrum.

[0009] This system also has certain limitations: the use of a frequency spectrum results in the wastage of limited and precious resources. Moreover, unless systems which are confined within extremely small geographical areas are provided, each system being associated with a base station, it is necessary to use transmission devices having a certain power level, in contrast to the need to keep the electromagnetic pollution within permissible limits and the intensity of the irradiated field, at any point in space, and therefore also at the source, below a predetermined safety threshold.

[0010] In order to overcome these drawbacks, in a similar manner to wired local networks and as described in the document US 4,638,453, radio communication systems have been proposed, wherein, in order to ensure the coverage of a suitably wide area with low-power transmitters, the various units which form the system are all organized so as to form a communications loop (or line) in which each unit forwards, during a subsequent time period, a message previously received from a unit arranged in order before it to a unit arranged in order after it, until a destination unit is reached.

[0011] If the number of units which form the loop is small, i.e. in the region of ten to a hundred, the system is effective, but it cannot be used in systems where the intercommunicating units are in the region of thousands or more, as in the case of street lighting systems.

[0012] The present invention solves these problems and offers an urban remote-surveillance system for street lamps which ensures an adequate territorial coverage using remote-control modules of the microprocessor type, with associated memory, each being associated with a street lamp, said modules being provided with very low power transceivers operating at the same frequency and communicating in half-duplex mode with a concentrator module, directly or by means of other modules which act as repeaters organized as nodes in a hierarchical tree structure managed by the concentrator module which interrogates the various units by means of polling procedure.

[0013] In the system, only one unit at a time is actively transmitting so that any possible risk of interference is avoided.

[0014] According to one aspect of the present invention, addressing of the interrogations to the various destination units is performed using a message structure which defines the route to be followed via nodes, only one of which at a time is authorized, in an ordered sequence, to transmit.

[0015] The same structure may be used for routing of the response.

[0016] According to another aspect of present invention, the modules which have the function of repeater nodes in the tree structure comprise a memory portion in which the identification code of the node/module which is immediately higher in the hierarchical order and the identification codes of the nodes/modules which are at least immediately dependent in the hierarchical order are stored so as to reduce the amount of routing information which is transmitted.

[0017] According to a further feature of the present invention, the remote-control modules are provided with fixing means for installation at the top of the street-lamp support structures in a predetermined oriented position with respect to the horizontal plane.

[0018] Advantageously the control modules, in addition to handling and monitoring the operation of the lamps with which they are associated, operate as centres for the acquisition of other information sent via radio waves or by means of digital inputs, such as for example the conditions of the nearest road display panels, the atmospheric, electromagnetic or acoustic pollution conditions, gas meter and/or electric meter readings and also images detected by digital photocameras.

[0019] The characteristic features and advantages of the invention will emerge more clearly from the description which follows, of a preferred embodiment provided

with reference to the accompanying drawings in which:

- Figure 1 is a schematic overall view of a remote-surveillance system in accordance with the present invention;
- Figure 2 shows the hierarchical tree structure used for radio-wave communications in the system according to Figure 1;
- Figure 3 shows a preferred format for the messages exchanged in the system according to Figure 1 having the structure shown in Figure 2;
- Figure 4 is an example of a time diagram which illustrates the transfer of messages between a concentrator module and a generic module C in the structure according to Figure 2;
- Figure 5 is a block diagram of a remote-surveillance module forming part of the system according to Figure 1;
- Figure 6 is a block diagram of concentrator module used in the system according to Figure 1.

[0020] With reference to Figure 1, the remote-surveillance system according to the present invention comprises a concentrator module 1 - communicating, by means of conventional communication means, such as a cellular phone and switched telephone network, with a control centre 50 - preferably but not necessarily housed in an electrical transformer cabin 2 which supplies the power for an electrical street-lighting system (or section) represented, by way of example, by four light sources 3, 4, 5 and 6 mounted on a post (or alternatively also suspended therefrom).

[0021] A remote-control module 7, 8, 9, 10 is respectively installed, as a component of the system, on each of the light sources.

[0022] Both the concentrator module and the remote-control modules are provided with a transceiver operating in half-duplex mode, i.e. alternately transmitting or receiving, in a mutually exclusive manner, at a predetermined frequency, preferably but not necessarily in the band ranging from 868 to 870 MHz, namely on a wavelength of about 0.34 m.

[0023] More generally it is possible to use any frequency assigned by national norms and international agreements to LPD (Low Power Device) transmission systems and to data transmission systems.

[0024] The various modules are therefore equipped with a short, vertical-style, quarter-wave antenna, no more than 84 mm long (in practice also less if loaded), which therefore has particularly intense and uniform characteristics in the horizontal plane and is much more attenuated in the other directions and even zero in the vertical direction.

[0025] The antenna may be integrated in the printed circuit supporting the logic storage and transceiver devices which form the module, or may also be external, omnidirectional or directional (also only for the radio-transmitting section).

[0026] The transceiver of the various modules preferably has a minimum power, with an irradiated power on the antenna of less than 5 mW, for which the current norms do not envisage operating licences and periodic checks, or in any case a power which is permitted for LPD equipment.

[0027] This results in a maximum - open-field - range which is extremely low, i.e. in the region of hundreds of metres, and a minimum - again open-field - range of about 100 m.

[0028] In these conditions it is obvious that the concentrator module 1 is able to communicate directly only with the modules, such as 8, 10, arranged in a radius not greater than 100 m. In the case of the modules such as 7, 9, arranged at a greater distance, direct communication is impossible or at least uncertain, at least for the modules arranged at a distance less than the maximum range, but greater than the minimum range.

[0029] In order to overcome this drawback it is possible, as is well-known, to use the modules in direct communication with the concentrator module, as repeaters. Thus, for example, as illustrated in Figure 1, if the module 9 is within the radius of communication of the modules 8 and 10, these two modules may be used equally well as repeaters for transferring messages from the concentrator module 1 to the module 9 and vice versa.

[0030] On the other hand, again by way of example, the module 7 is in communication with the concentrator module 1, by means of the module 8 alone operating as a repeater.

[0031] It is obvious that, with several repeater stages, it is possible to achieve the desired territorial coverage for urban districts or for an entire urban area.

[0032] This, apparently simple, solution of the problem is in fact complicated by the fact that the various modules may interfere with each other during transmission and cause scrambling of the messages transferred.

[0033] For example, if the concentrator module 1 transmits a message intended for the module 9, both the modules 8 and 10 could recognize the message and forward it, interfering with each other.

[0034] The situation could also be more complicated, if the module 9, in marginal receiving conditions, should recognize directly the message transmitted by the concentrator module 1 and transmit a response message which is superimposed on and interferes with the messages transmitted by the modules 8 and 10.

[0035] Differently from the known solutions in which, in order to prevent interference, the various modules operate at different frequencies and/or are organized in a loop-type, sequential, ordered structure, according to the present invention, the various modules operate at the same receiving/transmitting frequency, in half-duplex mode, i.e. alternately transmitting or receiving, and are organized in a hierarchical tree structure in which the initiative for sending a message and receiving a message is always exclusively taken by the unit which is higher ranking in the hierarchical structure (concen-

trator module) using a polling procedure which periodically interrogates one-by-one the other units, identifying them with a destination code and, if necessary, with further routing codes which identify in order the various units which must intervene in the message transfer process. Temporally speaking only one unit at a time is actively transmitting so as to exclude any possibility of interference, even though the various units all operate at the same transmitting and receiving frequency.

[0036] The configuration of the hierarchical structure may be defined during installation, taking into account the distances between the various modules, but preferably is defined upon initial operation of the system using an automatic procedure, as will be described in greater detail below, stored in the concentrator module 1 equipped, like the other modules, with a microprocessor and a memory of suitable capacity.

[0037] Figure 2 shows an example of a hierarchical tree structure for the system according to the present invention.

[0038] Each module, such as 11, 12 etc., is assigned, at the factory or upon installation, an identification code with N bits (for example 10 bits, allowing 1024 modules to be distinguished) which is permanently stored in the module or set with a DIP switch.

[0039] The memory of the concentrator module 1 contains a descriptive configuration table which, for each module identification code, determines in order, by means of the respective code, whether and which of the modules are to intervene in the communications process.

[0040] Thus, for example, if the concentrator module wishes to send a message to one of the modules such as 12, with which it is in direct radio communication, it is sufficient for it to transmit, together with the message, the identification code of the module 12.

[0041] The module 12 receives the message, recognizes itself as the destination and consequently operates, for example switching to transmission and returning, without the need for an identification code of the concentrator module, a response message indicating for example the state of the associated light source.

[0042] Other modules such as 11, 13 in direct communication with the concentrator module 1 (in that situated at a distance less than the minimum communication range) and in the receiving condition, certainly receive the message, but not recognizing themselves as the destination do not modify their state.

[0043] The same is applicable to more distant modules such as 21, 22, 23 ... 29, in the case where they should lie within the maximum transmission range of the concentrator module.

[0044] Let us consider, on the other hand, the extreme case of communication between the concentrator module 1 and the most remote module 41.

[0045] In this case, the concentrator module 1 transmits a message which contains, in an ordered sequence, the identification code of the modules 12, 25, 32 and 41 which recognize themselves in sequence as carriers of the communication and forward the message in cascade as far as the destination module 41.

[0046] The same process is repeated, in the reverse direction, for return of the response message.

[0047] In all cases, only the modules which are strictly defined by the routing path are involved in the communication process.

[0048] There is, however, a not secondary problem which must be dealt with. Generally the various levels I, II, ... V of the hierarchical structure are defined so that the modules of each level are able to communicate in a certain and reliable manner with the modules of the hierarchical level which is immediately higher and lower, but this does not exclude the possibility of communication, in marginal conditions, with the modules belonging to a hierarchical level which is further away from the immediately higher or lower level.

[0049] Therefore, with reference to the preceding example, if the identification codes of the modules 12, 25, 32, 41 are contained in sequence in the message transmitted by the concentrator module, the transmitted message may be simultaneously recognized by the modules 12, 25 and it is necessary to prevent the module 25 from taking transmission initiatives at the same time as the module 12.

[0050] In order to achieve this result, different solutions are possible:

I) A first solution consists in assigning to the modules 12, 25, 32, 41, which form the equivalent of a relay, a "token" which the various modules must pass on whilst performing their function.

Thus, for example, the concentrator module 1 when transmitting the message with the identification codes of the modules 12, 25, 32, 41 may associate with the code of the module 12 a marker code or "token" which assigns or gives authorization for repetition, in the absence of which it is not possible for a module to transmit.

It is thus obvious that if any one or some of the modules 25, 32, 41 should receive directly the message transmitted by the concentrator module 1, they are not enabled to operate in transmission mode, but must wait their turn.

The module 12 which receives the message and the token, when repeating the message, displaces the marker in sequence and associates it with the code of the module 25 which thus receives the authorization for repetition of the message and so on.

The same procedure may be followed for routing of a response message from the unit 41 to the concentrator module.

II) A second solution which has significant advantages compared to the preceding solution consists in storing in each module of the hierarchical struc-

ture, during the system configuration step, the code identifying the node or module belonging to an immediately higher hierarchical level (the concentrator module may be identified by default).

[0051] Thus, again with reference to Figure 2, the modules (nodes) 24,25,26 store the identifying code of the module/node 12 as their master, the module 32 stores the code of the module 25 as its master, and the module 41 stores the code of the module 32 as its master.

[0052] With this approach, the return and routing of a message towards the root of the structure, namely to the concentrator node 1, may be achieved automatically from any point in the structure, with the designation, during each message repetition step, of the destination module upstream.

[0053] Thus if, for example, the module 41, upon request of the concentrator module 1, must send a response message, it is sufficient for it to indicate, as the destination of its response message, the module 32, associating the corresponding code read in its memory with the message.

[0054] In turn the module 32, when forwarding the message received, indicates as its destination the module 25, and so on, as far as the concentrator module.

[0055] If we regard the routing information as service information, compared to the significant information which forms the rest of the message, it is obvious that with this solution the amount of necessary service information and the time spent for transfer thereof is reduced considerably, resulting in more rapid transfer of the useful information.

[0056] This applies not only for return of messages from any module to the concentrator module, but also for sending of messages from the concentrator module to the other modules.

[0057] If, in fact, the routing information for the return messages is no longer necessary as starting information, because it is acquired automatically by the structure, it is also true that the initial routing information, once used, becomes superfluous and may be removed from the following messages.

[0058] The token also becomes superfluous.

[0059] Thus, for example, if the concentrator module 1 sends a message to the module 41, it defines the routing path with the ordered codes relating to the modules 12, 25, 32, 41.

[0060] If the modules, such as 25, 32, 41, must also receive the message, they do not intervene because they recognize themselves in the ordered sequence as being successive to the module 12.

[0061] It is only the module 12 which, recognizing itself, repeats the message, in which, however, it omits repetition of its own identification code.

[0062] In the message thus repeated the module 25 recognizes itself as the first destination and proceeds with a further repetition, in accordance with the procedure already described.

[0063] In this way, from one repetition to the next, the amount of service information which must be transferred is reduced, with obvious advantages in terms of speed of transmission of the useful information.

III) A third solution which has further advantages combines the concept of an assigned token according to the first solution with the concept of local storage of the hierarchical structure.

[0064] According to this solution, each module of the structure has, stored in it, during the system configuration step, both the identification code of the node or module with an immediately higher hierarchical level (in this case also the concentration module may be identified by default) and the identification code of the nodes or modules with an immediately lower hierarchical level, belonging to the same branch.

[0065] Thus, for example, still with reference to Figure 2, the module/node 12 stores the codes of the modules 24,25,26 as subordinates; the module 25 stores the code of the module 12 as a higher-ranking module or as its master and the code of the module 32 (and other possible modules) as subordinate modules; the module 32 stores the code of the module 25 as its master and the codes of the modules 41, 42 as subordinates, and so on, until the end of the structure is reached.

[0066] With this approach, if for example the concentrator module 1 intends to send a message to the module 41, it is sufficient for it to transmit, as service information, the code corresponding to the module 41 and the code of the intermediate modules of the branch, which are separated by a hierarchical level, in this case only the module 25.

[0067] The module 12 receives the message, recognizes itself, even though not explicitly mentioned, as the sole master of the module 25 and forwards message, tagging the token authorizing forwarding onto the code of the module 25.

[0068] The module 25 receives the message, recognizes itself as authorized for transmission and forwards the message, omitting its identification code, namely sending as routing information only the code of the module 41.

[0069] The module 32, although not explicitly named in the message, recognizes itself as sole master of the module 41 and forwards the message, tagging onto the code of the module 41 the token authorizing it to proceed in accordance with the instructions contained in the message.

[0070] In the case where the destination of the message is a further module X subordinated to the module 41 in the structure, the routing mechanism is the same: it is sufficient to name the module X as destination and the modules of the branch, such as 31 and 12, separated by a hierarchical level, in order to establish the desired communication between the concentrator module,

the generic module X and vice versa.

[0071] Figure 3 shows, by way of example, the preferred digital format of a message which can be used in any one of the solutions mentioned above.

[0072] A first "START" field, of suitable length in numbers of bits, allows, in a known manner, all the units which receive the message to synchronize themselves with the data transfer frequency which is much lower than the carrier frequency and in the region of 110-200 KHz.

[0073] A second "FORM" field, consisting for example of 6 bits, defines with the first 3 bits the number of unit codes (from 1 to 7) which form the subsequent routing information ("ROUTE").

[0074] With the following 3 bits it is possible to specify whether the routing information is without a token (bits all zero) or accompanied by a token and to which of the codes it is assigned.

[0075] The following field, which is of variable length, contains in an ordered sequence the codes, for example A,B,C, which identify the modules involved in routing and the destination module.

[0076] The field "MESSAGE" contains the significant information (requests for command data or response information such as states, alarm conditions and the like) which are of no interest here.

[0077] The field "END" contains an end-of-message code by means of which transmission by the module transmitting the message is terminated and the transmission activity of another module can start.

[0078] In the case where solution II is adopted for routing, the field reserved for the definition and position of the token is superfluous.

[0079] Figure 4 shows a time diagram for the process of transmission and repetition of a message such as that shown in Figure 3, from the concentrator module 1 to the module C and vice versa.

[0080] In the time interval t0-t1, the concentrator module MC, which is actively transmitting, as indicated by the letter T, transmits the message.

[0081] Al the other modules are active in the receive state, as indicated by the letter R.

[0082] The module A recognizes the message and stores it temporarily.

[0083] When the message has been completely received, the module A assumes the transmission state and, in the time interval t1-t2, forwards the message, together with the necessary modifications in the routing code.

[0084] In the same time interval the message is received and stored by the module B which, during the next time interval t2-t3, forwards it to the module C.

[0085] The destination module C transmits a response message in the following time interval t3-t4.

[0086] This message, which is received by the module B, is forwarded in the time interval t4-t5, received by the module A and forwarded by the latter in the time interval t5-t6, during the course of which the response message is thus made available to the concentrator module MC.

[0087] During the next time interval the concentrator module can again be activated for transmission so as to interrogate another generic module.

[0088] Figure 5 is a block diagram of a remote-control module such as 7, 8, 9 and 10 according to Figure 1.

[0089] The module comprises a power supply unit 51 (AC/DC) which is connected to the network of the lighting system and which, in parallel with the back-up battery 52, powers the various components of the module, an output terminal block 53, for connection to a lighting lamp, an analog-digital converter 54 (AD) for detecting the power supply voltage/current of the lamp, a microprocessor 55, with a suitable number of programmable number of input/output (I/O) ports 56, a ROS control memory 57, for permanently storing a basic firmware, and a read/write working memory 58 for storing a modifiable firmware (FW) and data (including the messages which are temporarily stored during receiving), said data including, explicitly indicated, a master identification code (MASTER ID), namely of the remote-control module with an immediately higher hierarchical ranking and a plurality of codes (SLAVES IDD) identifying the modules with an immediately lower hierarchical ranking in the tree structure.

[0090] As already mentioned, this information is not indispensable, but corresponds to a preferred embodiment.

[0091] Information which is indispensable, on the other hand, consists of a module identification code (ID) which may be permanently written in a ROS 57, in a permanently external memory, not shown, or also may be provided by means of the programmable ports 56 or by a DIP switch 59.

[0092] The module is completed by a transceiver 60 with associated antenna 61, which is controlled during receiving or transmission by means of the I/O ports 56 which transfer the radio signals received to the microprocessor or modulate by means of a suitable system (PCM or the like) the transmission in isofrequency.

[0093] The module, by means of a relay 62, which is operated by means of the I/O ports 56 and an amplifier 63, switches the lamp (or also more than one lamp) on and off and controls the state thereof by means of the A/D converter 54 and the I/O ports 56, via which the microprocessor may also exchange information with other auxiliary equipment, such as devices for detecting the state of atmospheric pollution, the weather conditions (temperature, pressure, humidity) or acoustic and/or electromagnetic pollution. It is interesting to note that the module may also receive, provided that it is correctly identified as the destination, by means of the transceiver 60, information which is supplied not by other system modules, but by auxiliary peripheral remote-reading units (for example gas/water/electricity meters, or the like, and also digital telecameras), these also being equipped with a transceiver device and identifiable by

means of a code (being preferably activated upon request of the module in order to avoid transmission interference), said units using the system as a communications network.

[0094] Fig. 6 shows a block diagram of the concentrator module 1.

[0095] The concentrator module also essentially consists of a microprocessor 64 and a memory 65 for programs and data.

[0096] A memory area is specifically dedicated for storing a configuration map ("CONFIG MAP"), namely a set of tables which describe the tree structure of the system (Fig. 2) and define, with the respective identification codes, which modules are in direct communication with the concentration module - i.e. the modules of the second level, with respect to the concentrator module regarded as a first-level module - which modules are in direct communication with each of the first-level modules, and so on.

[0097] Alternatively or in combination, for the sake of easy access and polling, the configuration may be described using a single table in which the identification code of each module in the system regarded as a destination module (said modules being suitably ordered in an ordered arrangement which may be dynamically modified and defined with different levels of priority, as will be explained below) has, associated with it, in an ordered sequence, the code of all the intermediate modules which must be involved in the communication process between the concentrator module and the destination module.

[0098] Information which identifies the topographical location of the module is also associated with each identification code. The microprocessor 64 communicates with a serial port (for example of the RS232 type) via a cellular phone modem card 66 so as to send messages and receive instructions from a control centre 50 (Fig. 1) or sending messages of the SMS (Short Message Service) type to emergency stations via the cellular telephone system.

[0099] A second serial port 67 allows, with the same functional possibilities, the switched telephone network to be used. With a third serial port (for example of the RS 485 type) the microprocessor controls transmission or reception of a transceiver RTX 68 which has the function of sending and receiving messages from the modules in direct communication with the concentrator module. Programmable I/O ports, both of the digital type (I/O DIG) 69 and of the analog type (AI, with single input) 70, are also envisaged for control and communication with auxiliary equipment. The concentrator module is mains-powered by means of an AC/DC power supply unit 71, with back-up battery (not shown).

[0100] For the purposes of the present invention, more than a description of the ancillary functions which may be performed by the system, it is important to consider how the system is autoconfigured in a tree structure. Preferably, but not necessarily, the control module 1 is provided (for example by the control centre) with the list of the identification codes of all the modules which form part of the system, with the corresponding topographical location (road, post number, and the like).

[0101] At this point, the module 1, using a polling procedure, interrogates one-by-one the various modules (identifying them with the respective code), requesting them to send a message confirming receipt.

[0102] Obviously, the module 1 receives a response only from the modules located within the transmission/reception range. Preferably, an "emargination" operation is carried out on this set of modules, namely the interrogation operation is repeated at a lower transmission power (for example 50% less) in order to exclude from the set thus identified those modules which are situated in marginal receiving conditions.

[0103] The role of second-level masters is assigned (or if necessary sent) to the set thus identified.

[0104] By means of a further polling procedure in which a first of the second-level master units (followed by all the others) is designated as the intermediate communication carrier, the remaining modules are interrogated so as to identify, after emargination, which modules are in communication with the first (or with others) of the second-level master units.

[0105] The role of third-level master is assigned (and if necessary sent) to the set thus identified.

[0106] The operation is repeated for decreasing hierarchical levels until all the modules have been covered, with the possible identification of modules which, because of their location, cannot be accessed by means of radio communication and must be excluded from the system or checked for possible faults or malfunctions.

[0107] Obviously, if required by the communications protocol used, the identification of the respective master and the respective slaves is communicated to the various modules (and stored locally).

[0108] The configuration operation requires a relatively short amount of time which depends on the number of nodes and on the data transmission speed. In practice, a few minutes are sufficient for a thousand or so nodes (modules) and a transmission speed of about 100-200 Kbits/s.

[0109] Once configured, the system is ready to operate: the interrogation of the various modules for receiving, by way of response, information relating to their state is performed using a polling procedure, by means of which the various modules are interrogated one by one.

[0110] The interrogation time of each module depends not only on the transmission speed but also on its distance (in number of hierarchical levels of the tree configuration) and on the length (number of bits) of the interrogation message and the response message.

[0111] On average, if the number of hierarchical levels is in the region of 4-5 and the length of the messages is in the region of 100 bits and the transmission speed is in the region of 100 Kbits/s, a few milliseconds (3-5)

are sufficient for interrogating a module.

[0112] In a system which comprises several thousands of modules, the interrogation may therefore be repeated at an interval of 3-5 s.

[0113] It should be noted that in a tree structure it is possible to interrogate several modules in cascade using a single cumulative message, whereby the modules respond, from the one furthest away to the one closest to the concentrator module, gradually accumulating the respective messages.

[0114] This allows a further increase in the interrogation frequency, which is already high in relation to the type of events to be monitored.

[0115] It must also be noted that a polling procedure does not presuppose necessarily an interrogation frequency which is the same for all the modules: depending on the circumstances, and hence dynamically, it is possible to define several levels of priority which are assigned to the various modules and to interrogate with greater frequency those modules which have a higher priority.

[0116] The same criterion is applicable for the communications between concentrator module and control centre: once the concentrator module has collected alarm signals or indications of a fault or malfunction, these may be stored in the concentrator module and signalled in differed mode: only exceptionally, in particular conditions (risk of fires and the like), is the immediate signalling to the control centre or to other emergency stations required.

[0117] In the event of a fault or malfunction in a certain module adversely affecting the transfer of messages to other modules, it is obvious that the system offers many alternatives. By means of a reconfiguration operation, which may also be only partial, it is possible to identify the faulty module and restore communication with the other modules.

Claims

1. Urban remote-surveillance system, in particular for monitoring and operating a plurality of street lamps, comprising:

    - a plurality of modules (7,8,9,10) for remote-control of lamps, each module being combined with at least one respective lamp and equipped with a transceiver (60) and microprocessor (55) with respective memory (58), each module being identified by its binary code (59);
    - a concentrator module (1) equipped with a microprocessor (64) having associated memory (65) and a transceiver (68) for the exchange of messages with at least some of said remote-control modules as well as means (66,67) for communication with a control centre (50);

    characterized in that:

    - said concentrator module and said remote-control modules receive and transmit in half-duplex mode at the same frequency, only one of said modules actively transmitting at any moment;
    - said concentrator module contains in its memory (65) a map describing a hierarchical tree communications structure which defines message paths via none, one or several of said modules, so as to send and receive a message from a destination module, said concentrator module sending messages to said remote-control modules using a polling procedure, said messages identifying with said binary codes, a destination module and a message path.

2. Remote-surveillance system according to Claim 1, in which said path identification message comprises a marker code which identifies in said path which of the modules of said path is in each case assigned for transmission.

3. Remote-surveillance system according to Claim 1, in which said remote-control modules contain in their memory a code identifying the module with an immediately higher hierarchical order in said communications structure.

4. Remote-surveillance system according to Claim 3, in which said remote-control modules contain, each in their respective memory, the identification codes of the modules with an immediately lower hierarchical order in the branch of said hierarchical structure to which they belong.

5. Remote-surveillance system according to Claim 4, in which said path identification message identifies a destination module and intermediate modules along the path which are separated by at least one hierarchical level and comprises a marker code which identifies in said path which of the modules of said path is in each case assigned for transmission.

6. Remote-surveillance system according to Claim 1, 2, 3, 4 or 5, in which said concentrator module receives a single cumulative response message from at least some of the modules identified by said path.

7. Remote-surveillance system according to Claims 1, 2, 3, 4, 5 or 6, comprising auxiliary equipment for the remote reading of meters and/or video cameras, each equipped with transceiver and activated by the recognition of a command code, for remote-reading of the desired information.

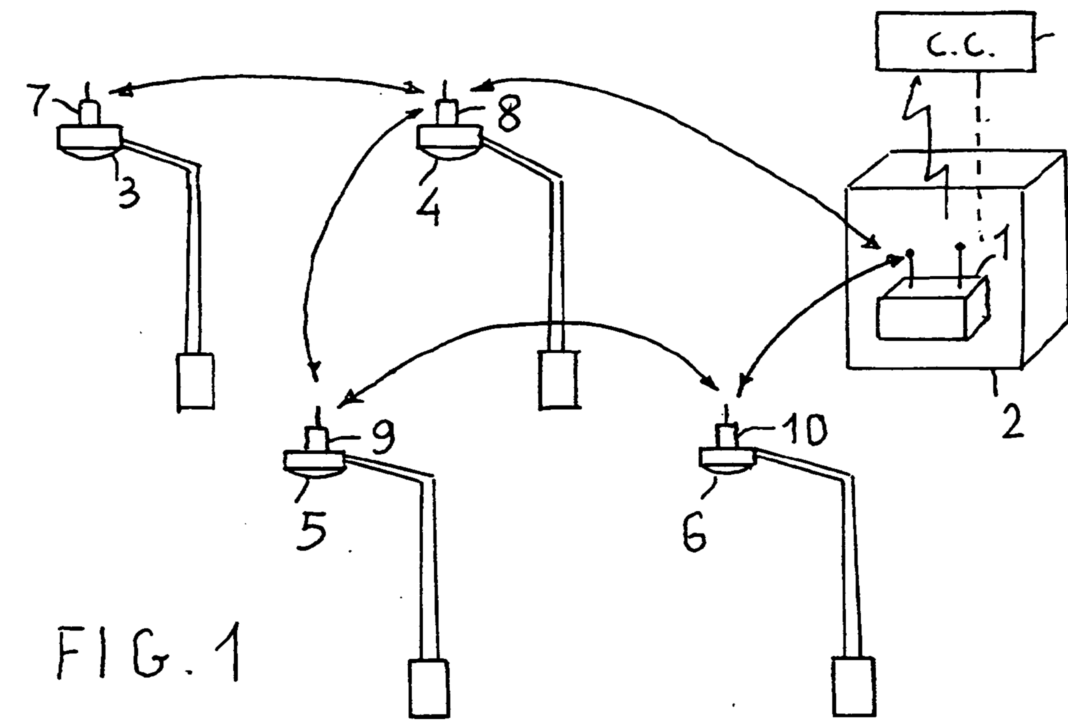
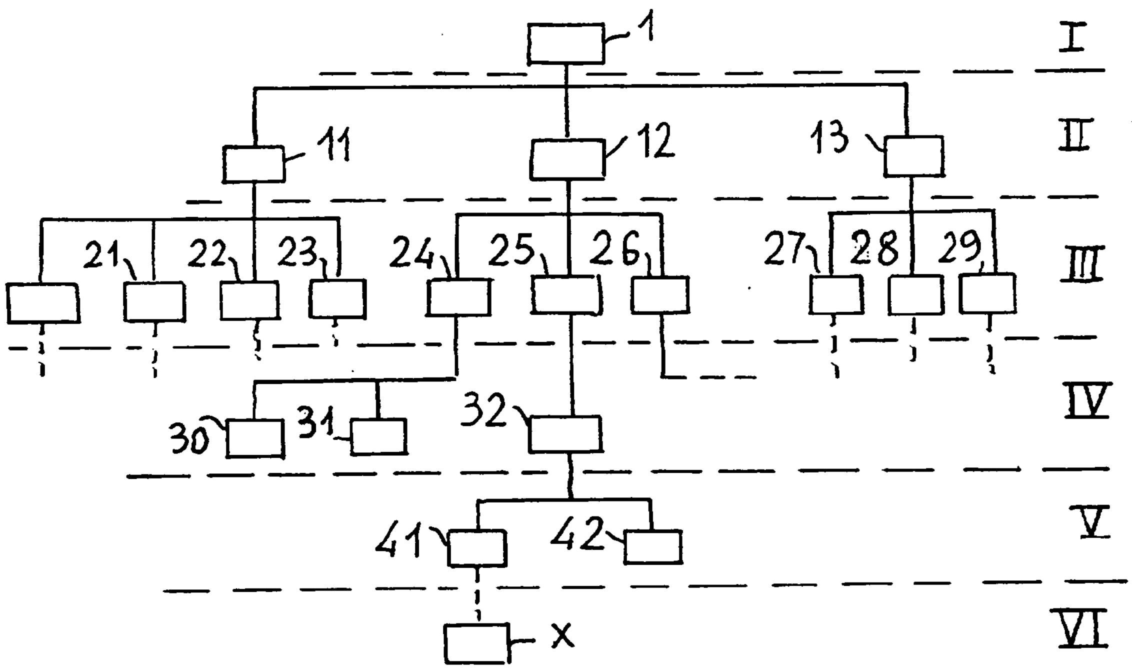

C.C.
50
7
8
3
4
1
2
9
10
5
6

FIG. 1


1
I
11
12
13
II
21
22
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26
27
28
29
III
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31
32
IV
41
42
V
X
VI

FIG. 2

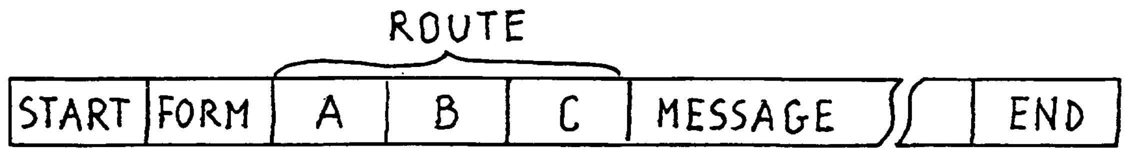

FIG.3

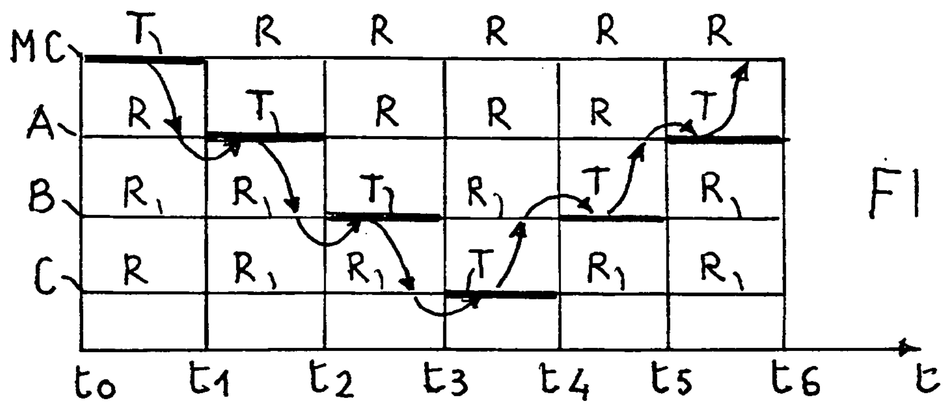

FIG.4

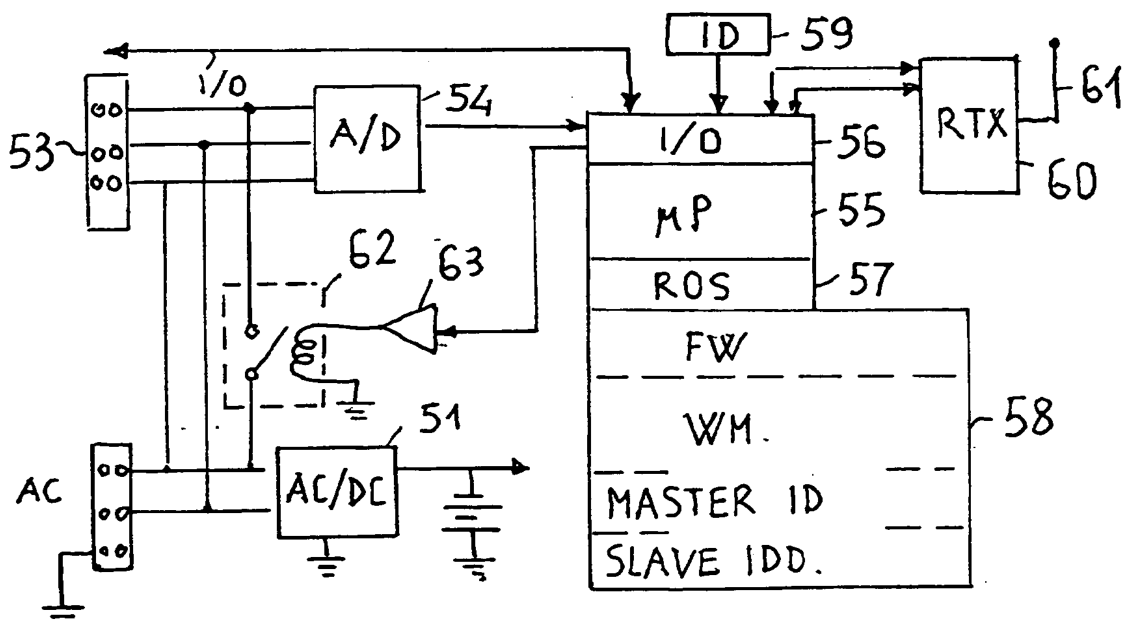

FIG.5

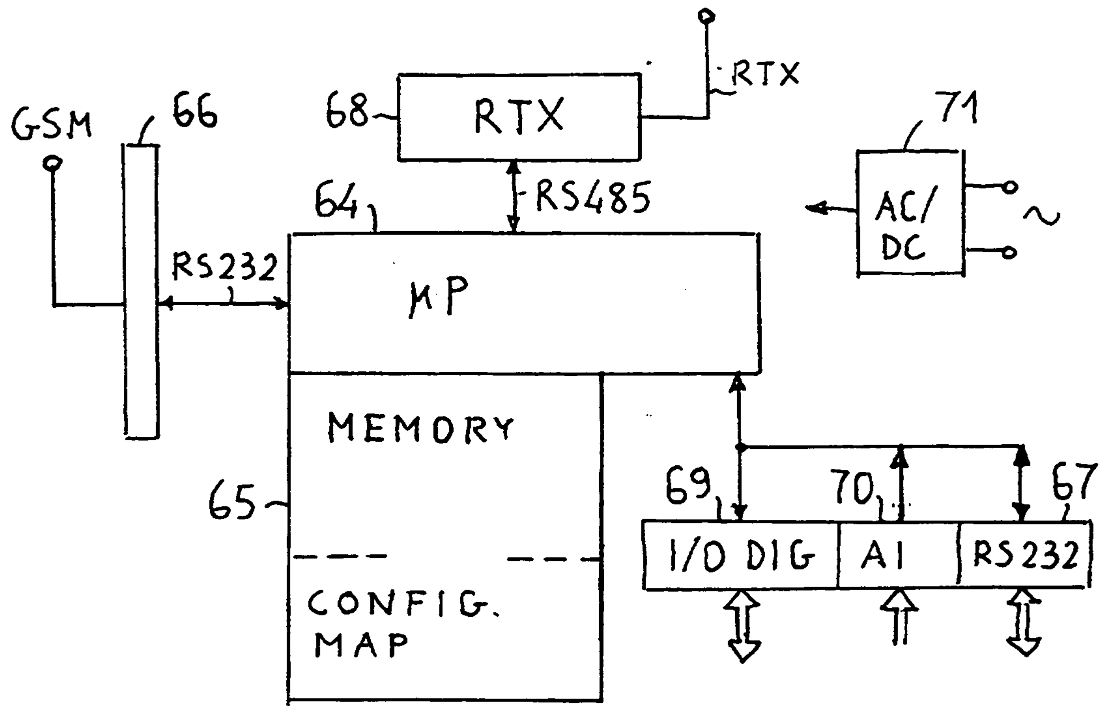
RTX
68
RTX
GSM
66
71
64
RS485
AC/
DC
~
RS232
μP
MEMORY
65
69
70
67
I/O DIG
AI
RS232
CONFIG.
MAP

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 83 0235

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X A	US 5 371 859 A (LENNARTSSON KENT) 6 December 1994 (1994-12-06) * column 1, line 10 - column 2, line 11 * * column 7, line 11 - column 18, line 12; claims 1-19; figures 1-9 *	1 2-7	H05B37/00 G06F13/36 G06F17/00 H05B41/00
A	US 4 425 628 A (BEDARD JAMES F ET AL) 10 January 1984 (1984-01-10) * column 1, line 6 - column 2, line 19 * * column 3, line 41 - column 12, line 54; figures 1,2 *	1-7	
A	US 5 936 362 A (ALT LARRY G ET AL) 10 August 1999 (1999-08-10) * column 1, line 13 - column 5, line 7 * * column 6, line 31 - column 13, line 59; claims 1-11; figures 1-7 *	1-7	
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			H05B G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	29 August 2002	Pierron, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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29-08-2002

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(19) Europäisches Patentamt
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(11) EP 1 251 721 A8

(12) **CORRECTED EUROPEAN PATENT APPLICATION**
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(54) **Urban remote surveillance system for street lamps**

(57) Urban remote-surveillance system for street lamps, in which a concentrator module (1) sends, using a very low power transceiver, by means of a polling procedure, a message to each of a plurality of remote-control modules (7,8,9,10) equipped with a very low power transceiver and organized in a hierarchical tree structure, defining in the message the destination module and a receiving/transmitting path consisting of a plurality of intermediate modules able to communicate with each other in succession, at the same frequency and without mutual interference, so as to obtain the necessary geographical coverage also using very low power transceivers.

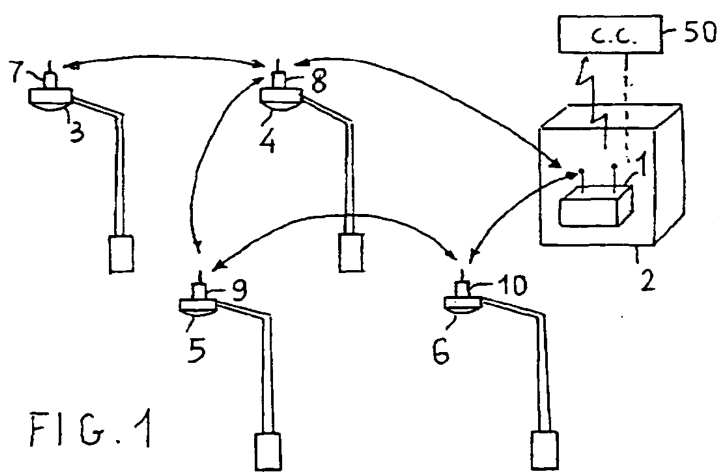

FIG. 1

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